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Television Captions for Hearing-Impaired People: A Study of Key Factors that Affect Reading Performance

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Closed captions are broadcast with television programs for special-needs viewers such as hearing-impaired people. We examined how caption presentation rate, small amounts of induced dioptric blur, and English learned as a second language affect the reading performance of good readers. Thirty-two college graduates with normal hearing and vision, half of whom learned English as a second language, read television captions that consisted of white capital letters equivalent in size to 20/92 Snellen letters on a black background. Text was presented at rates of 55, 120, and 216 words/min. Lenses of 0, 0.5, 1.0, or 1.5 diopters (D) were worn over the person's best refractive correction. The fastest text rate and small amounts of blur significantly disrupted reading performance. People who learned English as a second language were hindered more by presentation rate than by dioptric blur. Surprisingly, people with refractive errors (even though they were optically corrected) were hindered less by induced blur than were people with normally clear vision.

INTRODUCTION

Closed captions for television are much like subtitles on foreign films because they allow hearing-impaired people to understand the dialogue of television programs and movies. The closed transmission of this information as part of the regular video signal has been one of the most important technological developments for hearing-impaired people in this century. The debut of this service in 1980, after a decade of engineering development and public policy planning, made television accessible to a new potential audience of 18 million Americans who had been essentially left out when television became the dominant entertainment and information medium.

Captions are now transmitted for more than 200 h of broadcast and cable programming each week and are also available for most movies offered on videotape. However, despite the rapid growth of the service during the first 13 years, only about 2% of the potential audience bought the special decoder that makes it possible to see closed captions on any television set. Now it is no longer necessary to buy special decoders to see captions on a television set. A new federal regulation went into effect in July 1993 mandating that all new televisions sets with screens 13 inches (33 cm) or larger sold in the United States must have a built-in decoder chip. This

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regulation will eventually make captioning available in every U.S. household. Undoubtedly, this is a significant victory for hearing-impaired people and their advocates. However, an important gauge for measuring the response to the service has been lost, because we can no longer track the sale of decoders.

Because substantial amounts of public and private resources are supporting this service, and because the 98% of hearing-impaired people without decoders are still unable to fully understand the dialogue of television programs, it is important to identify the reasons behind the poor response to the captioning service. Conversely, we should also try to understand why so many of those who do use captions appear to be extremely enthusiastic about them.

Our previous research has suggested that captions may be too difficult for many people to read and enjoy (Thorn & Thorn, 1989). We have shown that if a person has even a slight visual problem, the caption letters are too small for maximum reading performance under normal viewing conditions. This research was the first controlled attempt to study the legibility of television captions. Our research addresses a fundamental question: Are the captions presented with television programs appropriate for the majority of people who might benefit from them?

There are several factors to consider when investigating the legibility of captions. First, caption reading is more difficult than many reading tasks. Because the text is divided into segments of one to seven words and displayed for a limited time, this leaves only a small margin for error. The original standard for caption presentation was 120 words/min. However, the largest captioning agency now captions verbatim unless the dialogue is faster than 150 words/min. A typical program may even have segments appearing at a rate of 160 to 170 words/min.

Second, many hearing-impaired people cannot read at normal fluency rates. Common reading problems such as dyslexia are found across all segments of the population, but the hearing-impaired population has other reading problems as well. Many deaf people learn to communicate in American Sign Language first, and English is acquired as a second language. Furthermore, hearing-impaired children who do not sign still cannot acquire language as naturally or as easily as their hearing counterparts. Scholastic achievement tests underscore a glaring deficiency: The average person graduating from a school for the deaf reads at only the third- to fourth-grade level (Schein & Delk, 1974; Trybus, 1978). Despite attempts to rectify this situation, below-par performance on normal reading tasks has remained virtually unchanged since testing first revealed this problem. A study by Stewart (1984) indicated how this problem can affect caption reading. A survey of 162 deaf adults who were members of a club for the deaf revealed that only 58% claimed to understand television captions most of the time.

Third, visual problems are more common in the hearing-impaired community than in the population at large. Studies have shown that children and young adults with congenital hearing loss are more likely to have visual problems than are normally hearing people. Although some of this is caused by syndromes that can produce pathological losses in both the auditory and visual organs (e.g., rubella and Usher's syndrome), the major cause for the high rate of visual problems in the hearing impaired is refractive errors. To make matters worse, if deaf people have a refractive error, they are also more likely than hearing people to have the wrong eyeglass prescription (Gottlieb & Allen, 1985; Johnson & Caccamise, 1983; Pollard & Neumaier, 1974).

Fourth, the largest subgroup of the hearing-impaired population is the elderly. The elderly usually have small visual losses caused by normal aging processes, and many develop pathological visual losses as well (Caird & Williamson, 1986). In addition, sensory processing capacity tends to slow with aging, especially on complex tasks that require switching between two or more activities (Kline & Schieber, 1982; Simonson, Anderson, & Keiper, 1967; Walsh, 1982). This would be expected to disrupt a complex task, such as watching a television program and reading the captions accompanying it, even when no pathological conditions exist (Cerella, Poon, & Williams, 1980; Craik, 1977).

Overview

We designed a series of experiments to test the legibility of television captions when people are challenged by small amounts of optical blur, moderate increases or decreases in captioning speed, or the late acquisition of English. Our early work focused on the relationship between caption reading and optical blur. Our present work focuses on the interplay of three parameters: optical blur, the rate of display (words/min), and the acquisition of English as a first or second language. We chose normal-hearing college graduates for this study rather than hearing-impaired people because of their ready availability and because we wished to first test the effect of blur and speed on a sophisticated, fluent population so as to measure these effects under the most favorable conditions.

METHODS

Observers

Thirty-two young adult optometry students with normal hearing and vision were tested. Of these, 16 had learned English as a first language (EFL) and 16 had learned English as a second or third language (ESL). In the ESL group, 8 learned a first language based on the Western alphabet (ESLa) and the other 8 learned a first language based on Chinese characters (ESLc). All observers were college graduates and successful optometry students who read English fluently.

The ESL students may be analogous to (though clearly not the same as) young, educated, hearing-impaired adults whose English and reading skills are not quite as fluent as their hearing counterparts.

Apparatus

Observers viewed captions on a 25-inch (63.5 cm) RCA SelectaVision Video Monitor from 3 m. The captions were displayed with a line-21 closed caption decoder (Telecaption I), which is available in the United States and Canada. We chose the caption style that presents words and lines without a change in position during display time (e.g., the lines do not scroll). The captions were composed of white uppercase letters on a black background and appeared in the lower portion of the monitor screen superimposed on video segments from 6 popular movies: *A Chorus Line*, *A View to a Kill*, *Cocoon*, *Rocky IV*, *The Empire Strikes Back*, and *The Big Chill*. The captions were recorded on half-inch (1.27 cm) videotape, and the experimenter controlled the presentation rate with a variable-speed Panasonic NV-8950 video cassette recorder.

The effect of blur on caption reading depends on the size of the television screen and the viewing distance. Under the conditions of our experiment, the caption letters were 2 cm high (0.8 inches) and viewed at a 3-m distance. This is slightly smaller than 20/100 Snellen letters used in visual acuity testing. This text size, which is about five times the size of a normal young adult's clinically measured visual acuity, produces good legibility and reading rate for people with normal vision (Legge, Pelli, Rubin, & Schleske, 1985; Legge, Rubin, & Leubker, 1987).

Testing Procedure

The observers viewed captioned movie segments with the sound off. Ten sets of captioned segments were produced for this study. Each set consisted of a practice segment followed by six captioned segments, one from each of the six movies used. Each movie segment consisted of three consecutive caption displays, which were composed of one to four lines of text per display and contained an average of 17 words. A set of six segments (excluding the practice segment) contained an average total of 101.2 words.

Each captioned segment was grammatically complete within itself (consisting of short monologues or dialogues) and was carefully chosen for consistency in level of difficulty. The captions contained no proper names, foreign words or phrases, swear words, or awkward word order, and the accompanying video portion did not portray any sex or violence. The format is similar to that used by the National Technical Institute for the Deaf in the Communication Performance Profile videotapes, which the college produced to test speech-reading ability (Johnson & Caccamise, 1983; Thorn & Thorn, 1989). The following is an example of the text that appeared in a captioned segment:

Display 1: [DO YOU WANT TO KNOW]
[ALL THE WONDERFUL THINGS]
Display 2: [THAT HAVE HAPPENED TO ME?]
Display 3: [I'LL TAKE THE TRUTH.]

Observers received eye exams before taking part in the study. Their best refractive correction was determined for the 3-m viewing distance so that all observers had the clearest possible view of the television display when they were not intentionally blurred. Additional positive lenses were then placed in trial frames or attached over their best corrective lenses to produce the desired amounts of blur. Observers read captions with four levels of blur (0, 0.5, 1.0, and 1.5 D) and at three speeds (56, 120, and 216 words/min). The four levels of blur focused the eyes at 3 m (clear), 1.2 m, 0.75 m, and 0.55 m and would be expected to reduce visual acuity from slightly better than 20/20 (4.4 mm high letters) to approximately 20/30 (6.6 mm high), 20/40 (8.7 mm high), and 20/70 (15.3 mm high). The 20/92 letter size of the television captions (20 mm high) is readily visible in a visual acuity test by normal observers with 1.5 D of blur.

Caption sets, speed, and blur conditions were presented in random order. However, speed and blur conditions remained constant throughout a caption set. Observers read the captions aloud as they appeared on the screen while the experimenter recorded responses on a prepared script. There was a 10-s pause between each segment. There was a longer pause between each set, during which the experimenter prepared for the next viewing condition. An entire session lasted about 1 h.

Data Analysis

Each set of six captions contained approximately 100 words (mean = 101.2; range, 99–103). We calculated the data in two ways. First, we simply counted the number of correct words and calculated the percentage of words correct for a set. This allowed us to calculate precise accuracy scores. Second, we counted the number of whole segments or captions that were read with perfect accuracy. This allowed an individual to achieve one of seven performance levels for a set (0 to 6 correct). However, people often miss unexpected words or the last part of a line or segment, so a caption's meaning can be lost with only one or two reading errors. Thus we believe the percentage of whole segments read correctly is a better (though imperfect) indicator of comprehension than is word count.

Two analyses of variance (ANOVAs) were used to test the data. The percentage of correct words and the percentage of correct segments were analyzed in a Language Group × Blur (in diopters) × Speed (words/min) three-way ANOVA. There were three language groups: the group of 16 students who learned English as a first language and those who learned English as a second language, which was divided into two groups of eight students each. To analyze specific concerns, the ANOVA was sometimes repeated, either with the 16 students who had learned English as a second language considered as one group, or with them treated as two subgroups that were then compared with each other (without the data from the EFL group).

Post hoc analysis of the data suggested that the refractive error of the observers may play a significant role in their ability to read blurred captions. Thus we performed four-way ANOVAs, including refractive error as a factor, and these results are discussed in the following section.

RESULTS

Both blur and fast presentation rate dramatically reduce reading accuracy. This was especially obvious when we analyzed our observers' ability to read whole segments without error. Performance decreased from 83% correct when clear to 22% correct with 1.5 D of blur for slow and normal presentation rates and from 30% to 0.5%

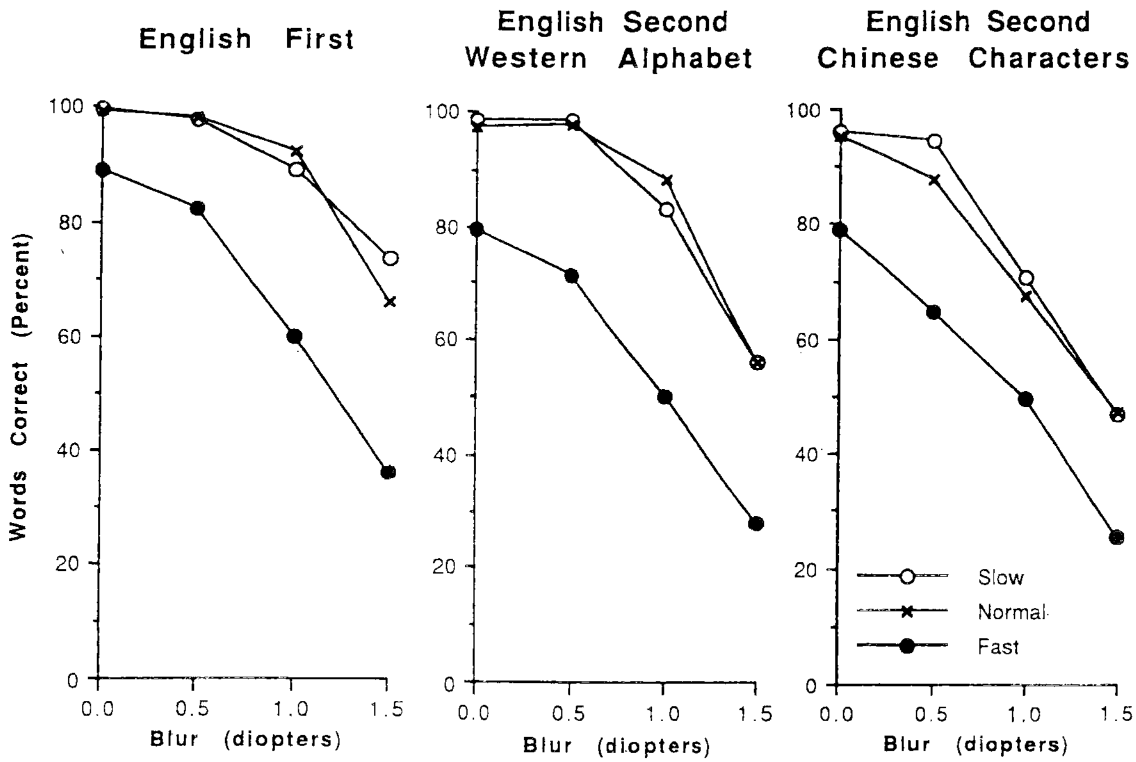

Figure 1. Under slow and normal presentation rates, word accuracy was better than 98% when clear but dropped to 60% with 1.5 D of blur. Fast presentation rate reduced accuracy, especially when text was blurred. The students' first language had a marginal effect on word accuracy. The greatest effect is for the most difficult reading conditions.

at the fast speed. Reducing the speed of captions from the normal rate had little effect on reading accuracy, but increasing caption speed reduced it dramatically. Observers with English as a first language performed slightly better than those with English as a second language under all conditions.

Word-Reading Accuracy

The effects of both blur and presentation rate were significant. Blur reduced word-reading accuracy, $F(3, 87) = 78.6$, $p < .00001$. This effect was equal for both slow and normal speeds, with 1.0 D and 1.5 D of blur reducing accuracy to 84% and 60%, respectively. The fast presentation rate reduced accuracy with all lenses, but the difference was greatest with increased amounts of blur. Both speed, $F(2, 58) = 176.3$, $p < .00001$, and the interaction between speed and blur, $F(6, 174) = 5.59$, $p < .0001$, showed highly significant effects. At the fast rate, word accuracy was reduced to 55% and 31% with 1.0 D and 1.5 D, respectively.

The main effect for the language groups was not quite significant, $F(2, 29) = 2.60$, $p = .091$. An ANOVA comparing the EFL group with the ESL group showed that the former performed significantly better than the latter, $F(1, 30) = 4.25$, $p = .048$, although this overall difference was small (Figure 1). An ANOVA directly comparing the ESL subgroup that learned a first language based on a Western alphabet with the group whose first language is based on Chinese characters showed no main language or language interaction effects.

The interactions between language groups and either blur or speed do not approach significance, $F(6, 87) = 0.838, p = .544$, and $F(4, 58) = 1.17, p = .334$. A significant three-way interaction for Language Group × Blur × Speed, $F(12, 174) = 2.52, p < .004$, suggests that for the easiest testing conditions, the groups did not differ but for conditions of intermediate difficulty (slow and normal speeds with 1.0 and 1.5 D of blur), significant differences are measurable. This interaction may be caused by a ceiling effect wherein all groups perform very well under the easiest viewing conditions (slow and average speeds with 0 D and 0.5 D).

Reading Accuracy for Whole Segments

When we examine the effect of blur on the ability to read whole segments correctly, the blur-induced reduction is far more dramatic. At slow and normal speeds, performance dropped from 83% correct when clear to 22% with 1.5 D. At the fast speed, observers accurately read only 30% of the segments when the captions were clear and dropped to less than 1% correct with 1.5 D of blur.

The ANOVA for correct segments also shows that both blur and presentation rate have a significant effect on reading accuracy, $F(3, 87) = 67.0, p < .00001$; $F(2, 58) = 135.3, p < .00001$. The Blur × Speed interaction effect is also highly significant, $F(6, 174) = 7.68, p < .0001$. It may seem surprising that this interaction effect is based largely on the fact that the fast presentation rate reduced performance the most with small amounts of blur (0 and 0.5 D). This is caused by a basement effect whereby

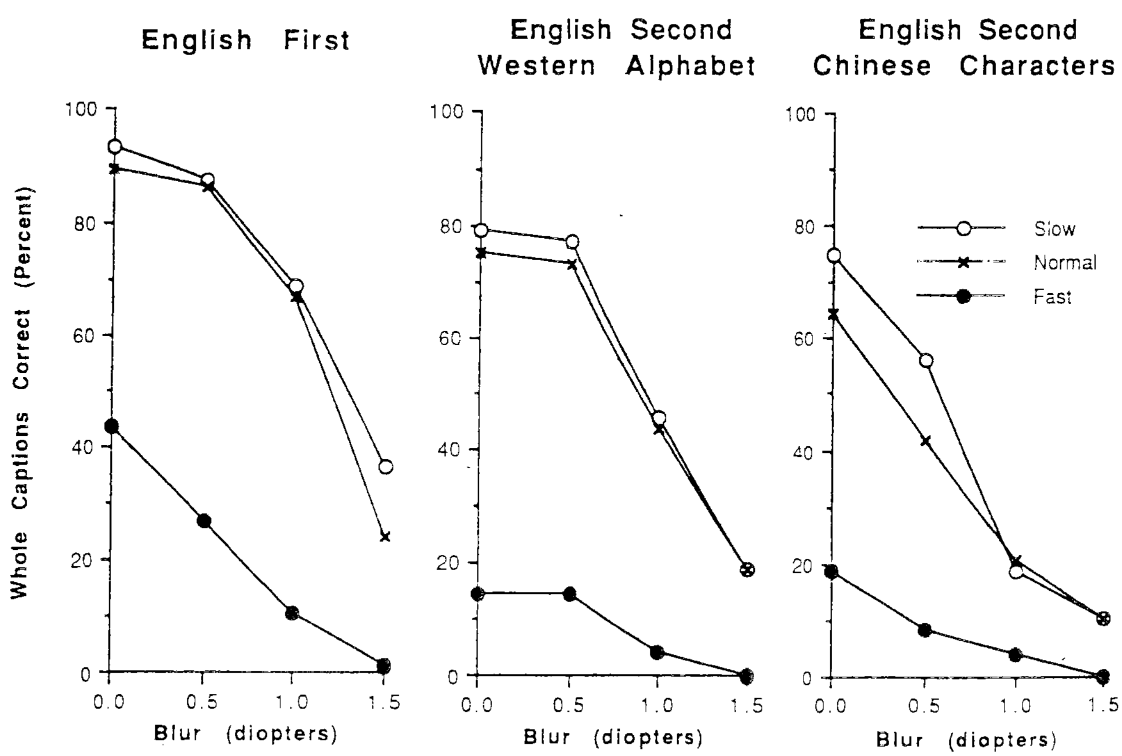

Figure 2. At the fast presentation rate, observers could rarely read all the words in a whole segment. At slower rates, 1.5 D of blur reduced accuracy to about 20%. Words, especially longer words, were missed most often toward the end of caption segments and lines. As a result, an observer might read 80% or 90% of a segment's words but miss the meaning. Performance was noticeably reduced for students who learned English as a second language, especially for those whose first language was based on Chinese characters.

performance was so poor with higher amounts of blur that there could not be a large difference between the slower speeds and the fast speed. Thus the difference between slower and fast speeds when clear is 83% versus 30% (52% difference) but 22% versus 1% with 1.5 D (only a 21% difference).

This method of analyzing the data also emphasizes the differences between the two main language groups (Figure 2). With 1.0 D of blur at slow and normal speeds, the EFL group read 68% of the captions correctly, whereas the ESL group was reduced to 32% accuracy. For the fast speed under clear viewing conditions, the EFL group performed more than twice as well as the ESL group (44% vs. 17%).

Few observers could accurately read complete caption segments with 1.5 D. The language group effect is significant, $F(2, 29) = 7.08$, $p = .003$, and the Language × Speed interaction effect is significant, $F(4, 58) = 2.82$, $p = .033$. This interaction may again be caused by a basement effect. Under the most difficult conditions, both groups performed very badly (and, therefore, similarly), whereas under moderate levels of difficulty, the performance differences were magnified.

A direct comparison between the students in each ESL subgroup shows that the eight who learned a first language based on the Western alphabet performed slightly better than the eight who learned a first language based on Chinese characters. However, none of these differences was statistically significant. The Speed × Language interaction was almost significant, $F(2, 28) = 3.16$, $p = .058$, given the basement effect noted earlier.

The Influence of Refractive Errors

On a post hoc basis we noticed that certain observers within different language groups seemed to be strongly affected by blur, whereas others were affected much less. We believed this observation was related to refractive error (Rx) differences among observers. Thus we performed a post hoc ANOVA for both word accuracy and segment accuracy to test this hypothesis. Both ANOVAs had four dimensions (Language Group × Caption Speed × Blur × Rx). The Rx dimension was divided into five refractive categories (Table 1).

Brief definitions of the refractive categories are provided here. Hyperopic people are at least 1.0 D farsighted and must normally adjust their focus (accommodate) to see objects clearly even at distance. In everyday life they often underaccommodate a small amount so that objects are slightly blurred at all distances. Emmetropic people see clearly at distance with no accommodative effort. Myopic people are nearsighted and cannot focus clearly beyond a certain distance without the aid of eyeglasses. Although myopes wear glasses most of the time, they are accustomed to viewing a blurred world in the morning, in the shower, and at numerous other times during the day.

There was no overall refractive error effect—word accuracy: $F(4, 25) = 1.81$, $p = .158$; complete segments: $F(4, 25) = 1.22$, $p = .327$. The Rx interaction with language groups—word accuracy: $F(4, 50) = 2.12$, $p = .092$; complete segments: $F(4, 50) = 3.29$, $p = .018$—and the Rx interaction with presentation rate were marginally significant—word accuracy: $F(8, 50) = 1.92$,

TABLE 1

Distribution of Refractive Error Types among the Difference Language Groups

Refractive Type	English First	ESL—alphabet	ESL—kanji
Hyperope (≥ +1.0 D)	(1) +2.120 D	—	—
Emmetrope (+0.75 D to −0.20 D)	(3) −0.083 D	(7) +0.141 D	—
Low myope (−0.25 D to −2.9 D)	(5) −1.810 D	(1) −0.870 D	(4) − 1.655 D
Medium myope (−3.0 D to −5.9 D)	(5) −4.246 D	—	(4) − 4.295 D
High myope (≥ −6.0 D)	(2) −7.685 D	—	—

Note: Number of observers appears in parentheses. Mean refractive error for each subgroup in diopters (D).

p = .092; complete segments: $F(8, 50) = 2.67, p = .016$, respectively. There was a highly significant Rx × Blur interaction in both ANOVAs—word accuracy: $F(12, 75) = 2.95, p = .002$; complete segments: $F(12, 75) = 3.06, p = .002$. These interactions demonstrate that people with higher refractive errors are better able to perform under difficult viewing conditions. This is shown in Figures 3 and 4.

For these figures the data from different language groups and different caption speeds have been categorized by refractive error. Both figures show that the performance of myopic people is unaffected by the amounts of blur that we have tested. Hyperopic people are less affected by blur than are the other refractive groups.

We were concerned that the refractive error effects may be the dominant effects in the experiment because we had not considered observers' refractive errors in the original experimental design. However, when we include Rx in the ANOVAs, all of the significant statistical effects previously described remained significant, and few showed any reductions in significance.

Figure 5 shows the effect of the amount of myopia on the accuracy of reading words and whole segments for clear versus 1.5 D of induced blur. It should be noted that a ceiling effect restricts the measurements for word accuracy when captions are clear, whereas the measurements for whole segment accuracy with 1.5 D of blur suffer from a basement effect. Although the effect of myopia on performance is most clearly demonstrated for the word accuracy data, the similarity between Rx groups when reading clear captions is demonstrated by the data for whole segments. For Figure 5, data for different language groups and different caption speeds have also been combined.

DISCUSSION

Why does blur reduce caption reading ability so much when vision is blurred only 1.0 or 1.5 D? Certainly, a person's ability to read equivalent-size letters on an eye doctor's chart would

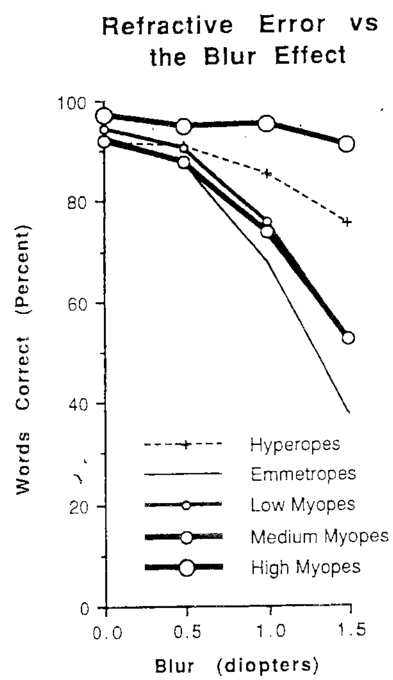

Figure 3. Percentage of words read correctly by the different refractive groups as a function of induced blur.

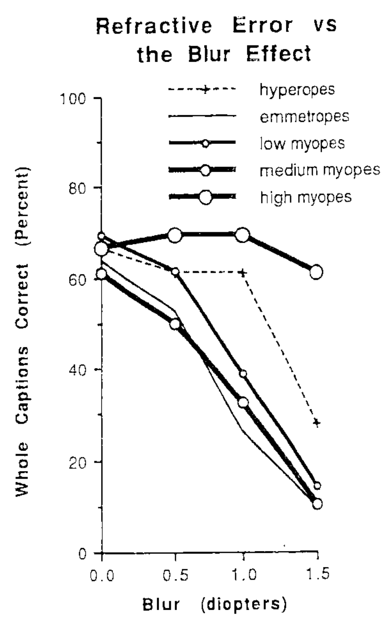

Figure 4. Percentage of whole caption segments read correctly by the different refractive groups as a function of induced blur.

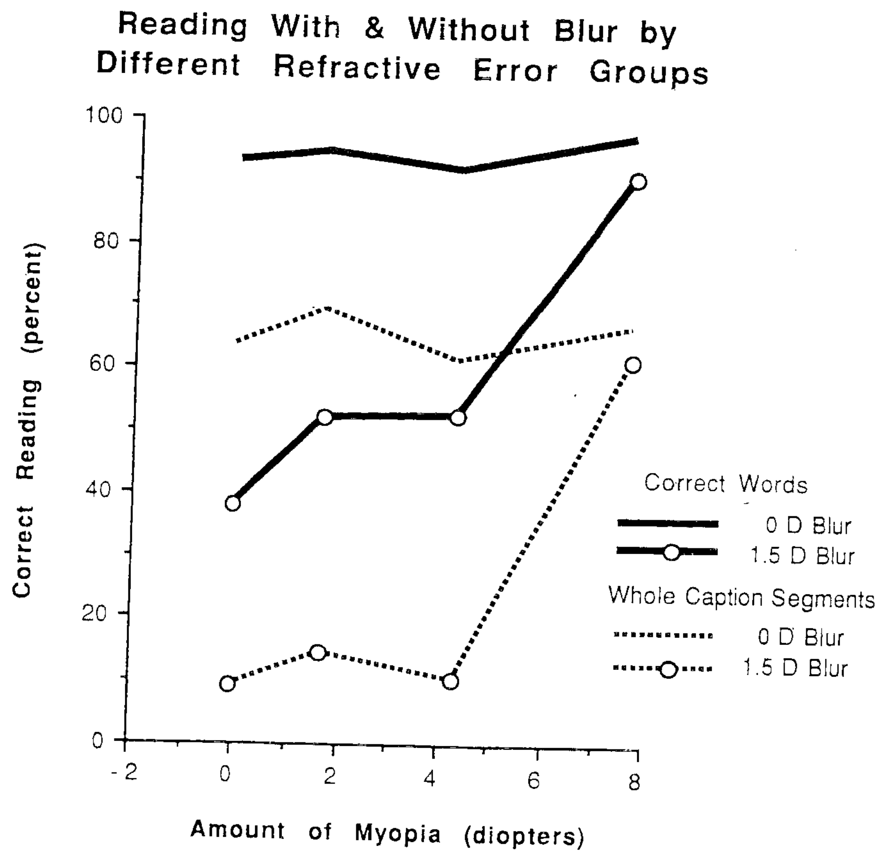

Figure 5. With clear vision, amount of myopia has no effect on performance (with word or segment accuracy). With 1.5 D of blur, performance improved as the amount of myopia increased.

not be affected by these amounts of blur. We believe that the most likely answer is simply that a person reading continuously presented text cannot ponder or recheck his or her first impressions. Rather, a reader has one good look at each letter in its context and then must move on. This simple view is supported by considerable data and has important implications for captioning.

Legge et al. (1985, 1987) have shown with continuously scrolled text that people with good reading skills can reach maximum reading speeds (for skilled readers, 300 words or more per minute) when text is 3 to 10 times larger than their clinically tested visual acuity letter size. If the average visual acuity of a young or middle-aged adult is better than 20/20, then fluently legible text could contain letter sizes as small as 20/60. This is much smaller than the caption text we used. However, when an observer's vision is blurred by 1.5 D, his or her visual acuity is reduced to about 20/70. Our caption text is, then, less than half the size needed for fast reading speeds.

A second factor may be proposed for the greater disruption of visual performance by blur for emmetropes than for myopes: There is a difference in the response of their ocular accommodation to blur. Gwiazda, Thorn, Bauer, and Held (1993) have shown that myopes tend to relax their accommodation in response to blur, whereas emmetropes tend to increase their accommodation to blur. These responses could prove to be inappropriate in both cases. When looking at a television across a room, myopes may conceivably have a reflexive relaxation of accommodation that maximizes clarity, whereas emmetropes may reflexively accommodate to blur that cannot be cleared, which would reduce clarity. In fact, we have recently shown that adult myopes and emmetropes do not change their accommodation in response to the lenses used in this study (Thorn, Cameron, Arnel, & Thorn, 1996).

For many tasks the size considerations discussed previously are not important for people with compromised vision. A specialist in vision rehabilitation would simply suggest that the patient move closer to the text or use a magnifier. This is not a practical suggestion for watching television. Television viewers are usually comfortable watching a large television from 3 to 3½ m. As the viewer moves closer so that the text is larger, the television raster becomes more obvious, and the surrounding action is spread further into the periphery of the visual field so that it becomes more difficult for the viewer to share attention between the action and the text.

This should be especially difficult for elderly viewers, who have more difficulty than other age groups when switching back and forth between two tasks. Given that these viewers have watched television programs primarily for the pictorial action, we believe they will be reluctant to use captions if they must sacrifice their habitual enjoyment of television by constantly switching between the video and an overly taxing reading task that can easily cause fatigue. After all, television is watched primarily for entertainment and relaxation.

Optometrists who specialize in the visual rehabilitation of patients with reduced visual abilities often refer to the difference between visual acuity and various reading tasks as *visual acuity reserves* (Whittaker & Lovie-Kitchin, 1993). The general rule for people with good reading skills is that for spot reading (reading letter by letter), text must be as large as a patient's visual acuity letter size; for low-fluent reading (80 to 100 words/min), text must be at least twice their visual acuity letter size; and for high-fluent reading (150 to 180 words/min), letters should be at least three times as large as visual acuity letter size. Patients with reduced vision rarely read at rates significantly faster than the high-fluent rate.

Considering that our high-speed captions were presented at 216 words/min, it is not surprising that caption-reading performance was affected by even the smallest amounts of blur. The original standard for captioning was 120 words/min, which is comfortably below the high-fluency rate. However, in analyzing caption speed on some favorite situation comedies now on television, we find that higher caption speeds (long periods of up to 160 words/min) have become closer to the norm. Reading at this rate should be compromised by small amounts of blur.

Clearly, our study has a serious flaw relative to the intended users of captions. Captions are not intended for people like our readers—college graduates working toward a doctorate degree. Rather, most hearing-impaired people are either elderly, with slightly reduced vision and slower information-processing skills in tasks requiring divided attention, or are congenitally hearing impaired with reading skills that are significantly below the performance levels of their hearing peers. Let us analyze how the caption reading of the intended users of captions might be affected by the factors studied in this experiment.

First, people who are congenitally or prelingually deaf normally read at about the third- or fourth-grade level. This means they have a reading vocabulary that is far more limited than that used in many television shows and movies and a maximum reading speed of about 120 words/min. In addition, congenitally deaf people have a high rate of visual disorders, especially problems caused by poorly corrected refractive errors (Gottlieb & Allen, 1985; Johnson and Caccamise, 1983; Pollard & Neumaier, 1974). Thus the vision of a great many congenitally deaf people is similar to that of our students when they performed with induced blur. If we consider the combination of visual disorders, limited reading vocabulary, and limited reading speeds expected in congenitally deaf people, then we must wonder if the current captioning system meets their needs. Our observers who learned English as a second language read at a college level, but even they were affected more by blur and speed than were those who learned English as a first language.

Late-onset elderly hearing-impaired people—the majority of the hearing-impaired population—is the other group that needs special consideration. They usually have reading skills equal to that of the normal hearing population, but they often have subtle visual losses and reduced information processing rates on complex tasks. In addition, they may tire from the continuous strain of extended, complex information-processing activities. Again, we must wonder if the caption text size and rate of presentation of closed captions address the needs of this group.

CONCLUSION

Our study suggests that the closed captions currently on television for hearing-impaired people may not serve many of the intended users because the captions are too small and fast for them to appreciate. Because it is technically feasible to present alternative captioning styles simultaneously during broadcasts, we believe that the simultaneous presentation of a second captioning style that has a slower rate of presentation and larger text may respond to some of the special needs of the hearing-impaired population. However, the introduction of any change in strategy must be approached carefully so as not to threaten the invaluable service to the hearing-impaired people who currently use television captioning.

In addition, captioning agencies cannot adopt such a policy until the parameters of the text needed for the congenitally deaf and elderly hearing-impaired populations are empirically determined through rigorous experimentation with these people. We are currently undertaking this task.

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